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Long-term Study of Phosphorus and Potassium Placement Methods for Corn and Soybean Managed with No-till or Tillage

Abstract

A study was initiated in 1994 to evaluate longterm effects of phosphorus (P) and potassium (K) fertilizer rates and placement methods on yield of corn and soybean managed with notill or chisel-plow tillage. No-till management results in little or no incorporation of residue and fertilizer with soil. Therefore, broadcast fertilization could be inefficient with no-till because both nutrients accumulate near the soil surface. In this case, subsurface banding of P and K fertilizers could be more effective.

Keywords

RFR A1081, Agronomy

Disciplines

Agricultural Science | Agriculture | Agronomy and Crop Sciences

Long-term Study of Phosphorus and Potassium Placement Methods for Corn and Soybean Managed with No-till or Tillage

RFR-A1081

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Introduction

A study was initiated in 1994 to evaluate long-term effects of phosphorus (P) and potassium (K) fertilizer rates and placement methods on yield of corn and soybean managed with no-till or chisel-plow tillage. No-till management results in little or no incorporation of residue and fertilizer with soil. Therefore, broadcast fertilization could be inefficient with no-till because both nutrients accumulate near the soil surface. In this case, subsurface banding of P and K fertilizers could be more effective.

Materials and Methods

The study consists of four separate trials: P for corn, P for soybeans, K for corn, and K for soybeans. Both crops are grown in rotation each year on adjacent areas of Mahaska and Nira soils. Tillage and fertilization treatments were applied for both crops, which were planted with a 30-in. row spacing. Plots managed with tillage were chisel-plowed in the fall and field-cultivated or disked in spring. Fertilizer placement methods evaluated were broadcast, deep-band, and planter-band until 2001, when the deep-band placement was discontinued. Broadcast fertilizers were applied in the fall and planter attachments apply bands 2 in. below and 2 in. beside the seed.

Fertilizer rates applied since 1994 with broadcast and planter-band placement methods for each P or K trial have been a control, a low annual rate (28 lb P₂O₅/acre or

35 lb K₂O/acre), a high annual rate (56 lb P₂O₅/acre or 70 lb K₂O/acre), the high rate applied one-half broadcast and one-half with the planter, and twice the high rate broadcast before each crop every other year (112 lb P₂O₅/acre or 140 lb K₂O/acre). In 2002, two treatments that applied 112 lb P₂O₅/acre or 140 lb K₂O/acre one-half broadcast and one-half banded with the planter were changed to twice this rate broadcast every year.

Results and Discussion

Tillage effects. Soybean yield has not differed between tillage systems. Until 2008, corn yield usually had been higher with tillage with few exceptions (on average, was 10 bu/acre higher for the fertilized treatments). The exceptions were a couple of dry years and one year when green snapping did not affect no-till corn but reduced yield with tillage because corn was taller at the time of the windstorm. In 2009 and 2010, both very wet seasons, corn yield was not clearly affected by tillage.

Fertilization effects. Yields with treatments that applied a similar P or K rate annually or every-other year before each crop have not differed consistently. Yields for treatments that applied all the P or K broadcast or one-half broadcast and one-half banded with the planter have not differed either. Therefore, these results are not shown.

Results for P. Long-term averages in Table 1 show little crop response to P because there was no yield response until 2003. Since then, both crops have shown responses. The low and high P rates differed only occasionally in the last few years. Soil-test P was high in 1994, decreased to a value between Low and Optimum by 2002, and has been Low since

then. There has been a more detrimental effect of P deficiency in the non-fertilized no-till plots than with tillage, which has become more evident in recent years.

Differences between P placement methods have been small and inconsistent. The planter-band method occasionally resulted in higher yield of corn, which is reflected in small differences for long-term averages (Table 1). The largest difference was in 2005 and was explained by drought, but differences seldom have been statistically significant, and the last two years showed no placement differences.

Results for K. Both crops have shown a significant yield response to K fertilizer since 1994 (Table 1), although differences between the low and high K rates have been very small. According to ISU soil-test interpretations, initial soil-test K was borderline between Low and Optimum but values for the checks had decreased into the Low class by 2001. The responses to K were larger for no-till (as it was for P) because K deficiency had a more detrimental effect on

yield with no-till than with tillage.

In early years of the study, yield responses to K fertilizer were slightly larger for the deep-band placement method that was discontinued in 2001. The broadcast and planter-band K placement methods seldom have differed. A small advantage observed for the planter-band method in 2004 and 2005 for no-till corn was not observed recently.

Conclusions

Tillage has not had consistent effects on soybean yield. Corn yield has been higher with tillage, however, but the yield difference has varied greatly over time. Crop responses to fertilization developed gradually over time as soil-test values of non-fertilized plots decreased into the Low interpretation class. Yield increases have been proportionally higher for crops managed with no-till because P and K deficiency translated into lower yield for this system. Differences between broadcast and planter-band placement methods have been occasional, small, and inconsistent, and long-term averages have not differed.

Table 1. Average effects of tillage, fertilizer placement method, and annual P and K application rates on corn and soybean grain yield from 1994 to 2010 and for the last two years (2009 and 2010).

Year			Crop			Till*			Phosphorus (lb P ₂ O ₅ /acre/year)						Potassium (lb K ₂ O/acre/year)					
									Broadcast†				Planter band		Broadcast†				Planter band	
									No P	28	56	112	28	56	No K	35	70	140	35	70
									----- Grain yield (bu/acre) -----						----- Grain yield (bu/acre) -----					
94-10	Soyb	CH	54.9	55.9	56.9	56.2	55.4	57.0	53.6	56.4	56.4	56.0	55.5	55.7						
		NT	52.6	54.9	55.3	56.1	55.1	55.7	53.0	55.7	55.0	55.2	54.8	53.3						
	Corn	CH	167	167	169	170	168	169	164	170	173	172	174	176						
		NT	151	160	160	160	161	164	152	164	164	165	164	165						
09-10	Soyb	CH	61.5	61.3	64.8	64.6	62.5	64.7	55.6	57.9	60.4	58.9	60.0	59.3						
		NT	57.2	62.2	63.4	65.6	63.0	64.4	58.0	62.5	60.2	59.5	60.1	55.0						
	Corn	CH	169	165	171	172	166	173	160	172	173	173	177	174						
		NT	151	176	176	174	173	174	145	176	174	176	177	179						

†The 112 lb P₂O₅ or 140 lb K₂O/acre per year treatments began to be applied in 2002 to plots that until 2001 had applied 56 lb P₂O₅ or 70 lb K₂O/acre per year deep-banded plus similar amounts banded with the planter.

*CH = tillage with chisel plow; NT = no tillage.